Soil Evaluator Course
Chapter Five
Documenting Site Conditions

The actual determination of site conditions is the culmination of all the theory discussed so far. This section will describe the value of site evaluation, proper procedures for conducting deep observation hole examinations and percolation tests, proper soil log preparation and how to put it all together to expedite final design and/or review.

See DEP website for form 11 Soil Suitability Assessment for On-site Sewage Disposal
http://www.state.ma.us/dep/brp/wwm/files/t5form11.doc

Value of Site Evaluation

Site evaluation is the first step in finalizing the design of an on-site sewage disposal system. It includes soil characterization, determination of maximum groundwater levels, percolation tests and identification of any special conditions that may exist on-site which could affect the design or performance of the sewage disposal system.

Historically, site evaluation has been accomplished through deep observation holes and percolation tests. The deep observation hole exposes the soil column for inspection and also allows for the determination of groundwater levels. Usually the soil profiles developed from observation holes are rather generic and the percolation rate is considered the overriding factor in governing design. However, regulatory changes to Title 5 recognize that not all percolation rates are created equal and that for a given percolation rate variations in soil type can dramatically affect the performance of the disposal system. As a result, it now becomes imperative that all site evaluators be able to accurately determine different soil types in order to insure proper design of sewage disposal systems.

Proper analysis and characterization of the soil is, perhaps, the most critical element in the design of an on-site sewage disposal system. Soil provides the treatment matrix, controls the hydraulic acceptance of effluent and can determine the success or failure of the system. Without a good initial evaluation of the site and soil, the disposal system may be doomed before it is ever put in the ground.

Preliminary Procedures

Site evaluation should begin even before going out in the field. Office preparation can provide the site evaluator with valuable data which will make the actual site visit more productive, identify the areas most suitable for subsurface sewage disposal and may preclude the specter of ugly and unwanted surprises.

At the very least, one should consult current soil survey maps, topography maps (USGS quadrangles or locally prepared maps) and local records available from health department or building department files. These sources will aid in determining the types of soil likely to be encountered and the surficial relief characteristics of the site (i.e. level, sloping, moderately sloping or severely sloping). The site evaluator should also identify known special conditions encountered in the area. These would include the presence of high groundwater, wetlands, “tough” soils, etc. All this information will help in identifying areas on the site appropriate for testing so that field time may be utilized efficiently.

It is important for site evaluators to know the engineer or health agent with whom they will be working. Have you worked with them before? Do they have any special preferences or practices?

If encountering someone unfamiliar, it is always best to discuss procedures and objectives beforehand. The site visit will proceed smoothly if everyone is aware of the ground rules from the beginning.

1.	**Water**	A minimum of 24 gallons is needed per percolation test. Bring sufficient quantities or have an available source on-site.
2.	**Post Hole Digger**	
3.	**Measuring Tape**	(25 foot minimum)
4	**Shovel**	
5.	**Batter Board**	Provides a reference level at the top of the percolation test hole.
6.	**18" Ruler**	Measures water levels during the percolation test.
7.	**Pocket knife**	Is useful in close up examination of the soil.

Percolation Test

In Massachusetts, the percolation test traditionally bas been the basis of design for subsurface sewage disposal systems. Essentially, it measures the rate at which clear water is transmitted through the soil in a twelve inch diameter by twelve inch deep hole in order to determine the suitability of the soil to accept effluent at the leaching elevation and to a depth four feet below. Since Title 5 relies on the percolation test to determine loading rates, it is the most important aspect of the site evaluation in terms of the design of the sewage disposal system. However, the percolation rate itself has little correlation to the actual infiltration rate of the effluent and the loading rates determined from percolation test results arc highly based on empirical data. The concept of the Long Term Acceptance Rate (L T AR) has gained wide acceptance in correlating percolation rates to design loading rates by taking into account such variables as soil type, biomat formation, moisture tension and other factors.

Title 5 requires that percolation tests be performed on the lot in all areas proposed for leaching, including the reserve area. Multiple tests may be required at the discretion of the approving authority when changes in the soil occur at various elevations within the hole or when changes in soil are noted across the lot. Multiple tests should also be required when the installation of a large leaching system is planned.

Safety should always be the prime concern during any field testing. As a general rule, one should never enter a hole deeper than one's chest height unless proper precautions have been taken to insure the stability of the excavation. Percolation tests should be performed on an excavated shelf that provides easy and safe access and egress. If the hole is deeper than chest height, the sides should be excavated at a minimum 3: 1 slope or reinforced with trench boxes. Oftentimes we take safety for granted; however, if a hole caves in on a person it can be fatal.

Title 5 describes the percolation test procedure. It must be emphasized that this procedure must be diligently followed, as any deviations will drastically affect the percolation rate. Remember, consistency in applying the procedure is of paramount importance.

Percolation tests are to be performed as follows:

1.	Prepare a test bole into the proposed leaching strata within the disposal area of 12 inches in diameter and 18 inches deep.
2.	Establish a fixed point at the top of the test hole from which all measurements can be

	taken.
3.	Scratch the bottom and sides of the test hole to remove any smeared soil surfaces. Either add two inches of coarse sand to protect the bottom from scouring, or insert a board or other impervious object in the hole so that water may be poured down or on it during the filling operation.
4.	Carefully fill the hole with clear water to a minimum elevation of 12 inches and maintain the water level by adding water as necessary for the purpose of soil saturation, but in no case less than fifteen minutes after first filling the hole.
5.	After saturation, if the water level drops to a depth of 9 inches in less than 60 minutes, measure the length of time for it to drop from a depth to 9 inches to a depth of 6 inches. If the rate is erratic, in the opinion of the approving authority, the hole shall be refilled and soaked until the drop per increment of time is steady. The time for the level to drop from a depth of 9 inches to a depth of 6 inches divided by 3 will be the percolation rate in minutes per inch.
6.	If the initial 3 inch drop requires more than 30 minutes (rate equal to more than 10 minutes per inch) the soil shall be saturated by filling the hole to the top and maintaining it full for at least four hours. The soil should then be permitted to swell overnight so that the soil conditions will approach those that exist during the wettest season of the year. After the overnight swelling period, the test shall be made again by filling the hole to a 12 inch depth and maintaining that level for 15 minutes, letting the level drop to 9 inches, then timing the drop between 9 inches and 6 inches. The time elapsed between 9 inches and 6 inches, divided by three, shall be the percolation rate.

Deep Observation Hole

The deep observation hole is excavated in order to determine and record the kind of soil on- site and to determine maximum high groundwater elevations. The information determined from the deep observation hole is critical in assigning a correct soil type and, along with the percolation rate, will determine the appropriate loading rate to be used in designing the sewage disposal system.

Deep observation holes must be excavated on every lot on which a leaching facility is proposed. Holes must be excavated to a depth 4 feet below the bottom of the proposed leaching facility and should be a minimum of ten feet deep. There are instances however when the ten foot depth is not attainable due to the presence of bedrock or other limiting factors.

The deep observation holes should be located in the area of the proposed primary and reserve leaching systems. Site characteristics such as topography, drainage and slope should indicate the most suitable location of the holes.

Soil Logs

Soil logs are the record of the site visit. They should include the data necessary for the design of the sewage disposal system. Essentially, the soil log should show the soil profile with

appropriate horizon identified, general location of all test holes, percolation test results, percolation test depths, soil classification and the presence of ground water and elevation of maximum groundwater.

Whereas design loading rates are based on soil classification as well as percolation rate, it is important to indicate the soil type as determined from the USDA Textural Triangle on the soil log. Having all this information on a well-organized and standardized form will aid greatly in providing accurate information for future reference.

Accuracy is important in preparing the soil logs because, as previously stated, it will be the record of the site visit. One cannot rely on memory to fill in gaps in the soil log. Accurate logs are invaluable in establishing a database of local conditions that in turn will make future site evaluations easier and more productive. In addition, accurate soil logs can provide answers if someone were to have questions at some time in the future.

Putting It All Together

After the site visit is over .the information should be reviewed and checked against any preliminary plans that have been prepared. In this manner, appropriate siting of the sewage disposal system can be confirmed and the design can proceed to completion.

If the procedures outlined in this chapter are followed, site evaluation will provide valuable data on which a subsurface sewage disposal system can be properly sited and designed. While the process will not always be easy or necessarily run smoothly, proper preparation and procedure will go a long way in overcoming the inevitable glitches that plague those who toil in the field.

SOIL EVALUATION CRITERIA

- Every proposed disposal area shall be assessed based on the following criteria:
  - deep observation hole testing
  - soil profile determination
  - percolation testing
  - landscape position
  - hydrogeologic properties

- Soil evaluation may be performed at any time of the year.

- Time of testing should be recorded especially in relation to the existing hydrologic conditions.

SOIL EVALUATOR TRAINING COURSE

DEEP OBSERVATION HOLE

- Purpose is to determine the following:
  - soil profile in the proposed disposal area.
  - depth of overburden above ledge, bedrock or impervious layer(s).
  - observed groundwater elevation at the time of testing.
  - adjusted groundwater elevation.

- At least 2 deep observation holes for every proposed disposal area.

- Additional holes may be needed to evaluate soil variability.

- Location of deep observation holes should be determined from obvious and permanent benchmarks and noted on the design plans.
- Secure deep holes to prevent accidents.

- Deep observation shall have the following 2 segments:
  - one segment about five feet deep to allow for detailed soil observations;
  - an adjoining, deeper part at least 10 ft deep; or
  - extending at least to a depth of 4 ft below the bottom elevation of the proposed soil disposal area if ten foot holes are impossible because of
  - an adjoining, deeper part at least 10 ft deep; or
  - extending at least to a depth of 4 ft below the bottom elevation of the proposed soil disposal area if ten foot holes are impossible because of
  - High water tables
  - shallow bedrock or saprolite.
  - human safety.

SOIL PROFILE

- Soil log shall contain the following information for each soil horizon:
  - depth limits of horizon.
  - soil colors including abundance, size and contrast of mottles.
  - SCS soil textural class
  - estimated percentage of coarse fragments
  - soil structure
  - soil consistence

- Estimate the maximum high groundwater elevation from:
  - observations of the actual high water table during times of seasonal high water tables;
  - soil morphology and reference wells to correlate water tables during periods when the water table is not at the annual high range;
  - USGS (Frimpter) method to estimate seasonal high water tables;
  - in coastal areas subject to tidal influence a DEP approved method.

- Determine the presence of 4 ft pervious, naturally occurring materials throughout the proposed disposal area**.**

DEP Soil Evaluator Course – Soil Log Example

Deep Hole Number:1 Date: March 1, 2000 Time: 9:15AM Weather: clear

Location: NE corner lot #1, see site plan for exact location

Land Use: abandoned hayfield Slope 7% Surface Stones <10%

Vegetation: grass, gray birch, red maple

Landform: drumlin

Position in Landscape: midway slope, see sketch on p. 3

Distances from:

Open Water Body: > 300 feet Possible
Wet Area: > 300 feet Drinking Water Well: 200 feet
Drainage Way: > 300 feet
Property Line: 75 feet Other

DEEP OBSERVATION HOLE LOG

Depth from Surface	Soil Horizon	Soil Texture (USDA)	Soil Color (Munsell)	Soil Mottling	Other
0 – 6	Ap	Fine sandy loam	10YR 3/2	None	Granular, friable 5% stones
6 – 24	Bw	Fine sandy loam	10YR 5/8	None	Weak blocky, friable, 5% gravel
24 – 36	BC	Sandy loam	10YR 5/3	10% fine 2.5YR6/2 and 10% med. 7.5YR4/6	Massive, friable 10% gravel/stones
36 – 120+	Cd	Sandy loam	2.5YR 5/2	Many fine 10YR 6/2 and 10 YR 5/6	Platy, very firm, 10% gravel

Parent Material: compact till

Depth to Bedrock: > 10 feet

Depth to Groundwater:

Standing Water in the Hole: 36"
Weeping from Pit Face: 32"
Estimated Seasonal High Water Table: 24"

Percolation hole: >42"

Soil Evaluator Training Course

Percolation test Procedure

- Conduct the test in the most limiting soil layer.
- Test may be conducted at any time of the year except when soil is frozen.
- Two test holes per site:
    - One located or very close to the proposed leaching area
    - One located in or very close to the proposed reserve area
    - More testing may be required depending on soil variability and size of disposal system proposed.
- Test hole specifications:
    - Diameter: 12”
    - Depth: 18”.
- Establish fixed reference point.
- Scratch the bottom and sides of the test hole to remove smeared soil surfaces.
- To prevent scouring of the hole bottom, while pouring water in the test hole, either put 2 inches of a coarse sand, or use a board or other impervious object at the bottom of the hole.
- In very sandy soils a coarse wire mesh or perforated liner may be used to prevent sloughing of the soil and to maintain proper hole dimensions.
- Carefully fill the hole with water to a minimum of 12” from the bottom of the hole.
- Add water to the hole as needed to maintain the level to a minimum of 12” above the bottom of the hole for a period of at least 15 minutes.
- After this saturation period, if the water level drops to a depth of 9” in fewer than 30 minutes, determine the length of time required to drop the level from a depth of 9” to a depth of 6”.
- Calculate the percolation rate by dividing the number of minutes for the water level to drop from 9" to 6” by 3.
- If the drop from 12" to 9" requires more time than the initial 30 minutes, the hole should be filled to the top and the water level should be maintained at that level for at least 4 hours.
- After an additional 12 hours to allow for swelling of the fine grains, carefully fill the hole with water to a minimum of 1 2 " from the bottom of the hole.

- Add water to the hole as needed to maintain the level to a minimum of 12 " above the bottom of the hole for a period of at least 15 minutes.
- Let the water level drop to 9” and determine the length of time required to drop the water level from 9” to the 6 " level. Drop the level from a depth of 9” to a depth of 6”.

- Calculate the percolation rate by dividing the number of minutes for the water level to drop from 9” to 6” by 3.

- In coarse sands and similar rapidly permeable materials when at least 24 gallons of water has been added to the hole within 15 minutes and it is impossible to obtain a liquid depth of nine inches, a percolation rate of 2 minutes/inch is assumed.

LANDSCAPE POSITION

- Identify and record the topography of the proposed disposal area on the evaluation form.

- Record features that may negatively affect the functioning of the system including:
    - bedrock outcrops and areas with many coarse fragments
    - steep slopes (greater than 3 : 1) exhibiting signs of unstable soil
    - highly disturbed soil (presence of construction debris, etc.).
    - low-lying coastal areas exhibiting signs of tidal inundation or tidal marsh vegetation.
    - low-lying inland areas exhibiting signs of surface water runoff, ponding or freshwater vegetation.
    - flat low-lying areas adjacent to surface water bodies and streams.

- The boundary of a velocity zone shall be determined by reference to the National Flood Insurance Program Flood Data and Flood Insurance Maps for each community.

SOIL EVALUATOR TRAINING COURSE

Hydrogeologic Properties

- The following hydrogeologic properties shall be identified and recorded on the evaluation form:
    - estimated direction of the groundwater flow
    - groundwater table elevation
    - observed.
    - adjust by USGS water year data and/or soil mottling.
    - actual or estimated depth to bedrock
    - depth of the unsaturated soil zone
    - SCS soil drainage class
    - lateral distance to surface water and/or wetland boundaries
    - location of every public or private water supplies:
        - within 400 ft of the proposed system location in the case of
        - surface water supplies and gravel packed public water supply wells;
        - within 250 ft of the proposed system location in the case of tubular public water supply wells;
        - within 1 50 ft of the proposed system location in the case of private water supply wells.

- Approximate safe yield or design capacity of every public water supply, if information is available.

- Location of proposed disposal area in relation to Nitrogen Sensitive Areas designated by 310 CMR 15.215

Estimating Maximum Groundwater Elevation

- WET SEASON
  - when is the wet season truly wet?
  - allows testing only during a limited time period
  - how representative is the observed water level?
- USGS Procedure
  - allows prediction throughout the year
  - works well in large, unconfined sandy strata such as outwash and deltas
  - prediction general in scale, does not precisely estimate onsite conditions
  - limited applicability in confined deposits such as clays and tills
  - requires some technical skills
  - need reference well close by
- WET SEASON BASED ON LOCAL WELL NETWORK
  - better estimate as to how wet is wet
  - requires long term time and financial commitment
  - does not estimate actual onsite conditions
- SOIL MORPHOLOGY
  - does not estimate absolute maximum high groundwater elevation, but a more average value
  - can be used throughout the year
  - requires interpretive skills
  - morphology reflects long term hydrology

Field Procedures for Determining USDA Textural Classification